Interphase Materials by Forced-Assembly of Glassy Polymers

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Using layer-multiplication technology we are able to forced-assemble new nanolayered polymeric systems as illustrated on the right, Figure A. The image shows a magnified section of a film composed of more than four thousand continuous and uniform alternating layers of polyester (dark strips) and polystyrene. The individual layers are less than 100 nanometers in thickness.

The physical properties of these nanolayer films can be utilized to probe interphase structure-property relationships. The layer-thickness dependent glass transitions of nanolayer PC/PMMA films is seen on the right (Figure B), encompassing the importance of interphase which starts to become dominant below 100nm layer thickness. At 10nm scale, the film is composed entirely of interphase characterized by its single glass transition. A new class of material, *interphase material*, is created.

For the first time, we have demonstrated Helfand's interphase theory using interphase thicknesses experimentally determined for polymer nanolayered films with various degrees of interaction, Figure C.

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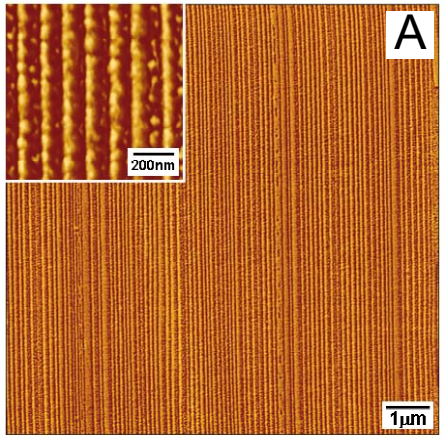

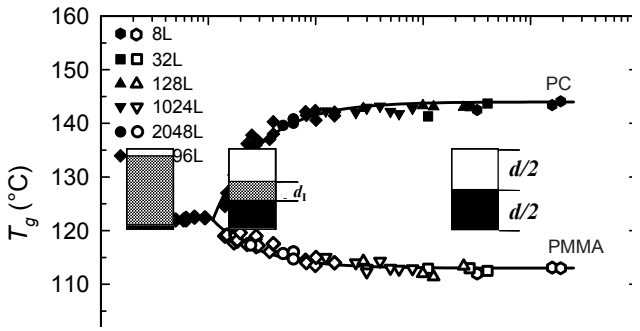

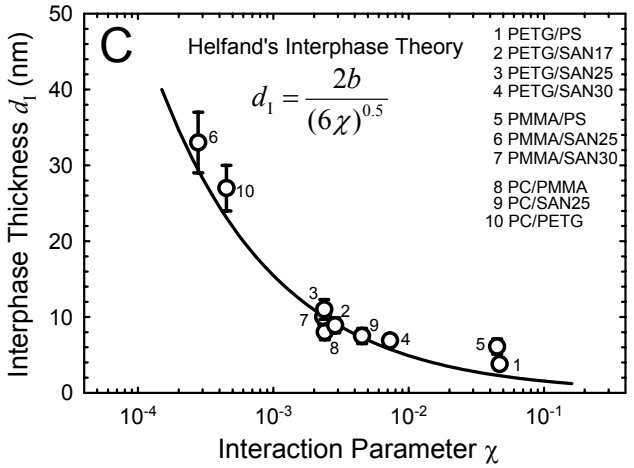

Polymer Structure-Property Relationships at the Nanoscale

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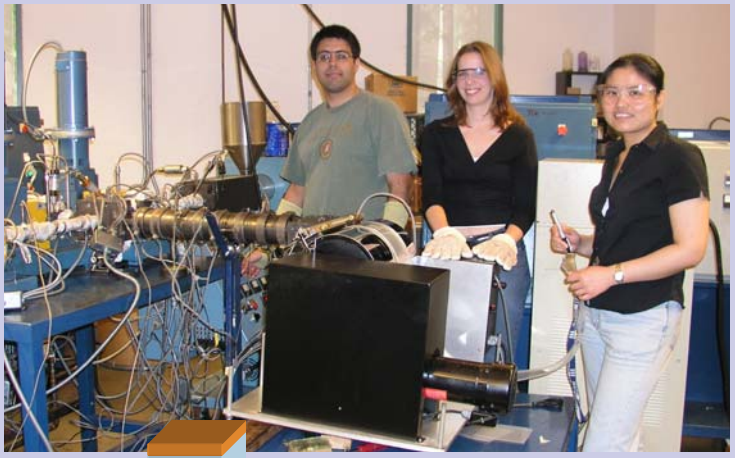
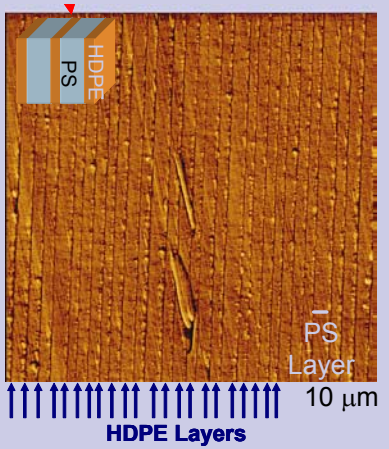
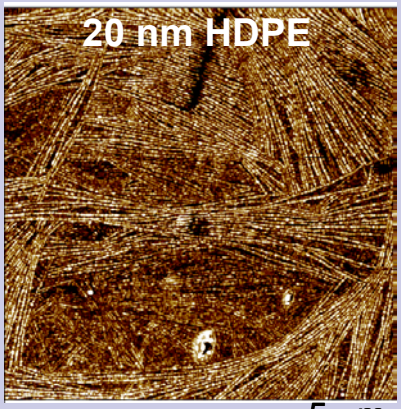
Education and Outreach

The project prepared students to participate in the design and synthesis of the advanced materials systems that will be required in the future. The project provided those working on it with experience in process design, in operating and maintaining a unique coextrusion line, and in using it to create novel materials systems. In preparing for their future roles as polymer scientists and engineers, they learned how to work in a group to define a research problem, how to design an experimental approach to the problem, and how to apply analytical tools as required. They gained experience in communicating their research findings to the larger technical community through the mechanisms of oral and poster presentations.







L. Somlai (Research associate), Meghan Smith and Yi Jin (Ph.D. students) making nanolayered films at our extrusion laboratory (top left). AFM image showing the cross section of a nanolayered film with 20 nm HDPE layers (top right). AFM phase images showing the contrasting morphology of HDPE in micro and nanolayers (bottom).